National Nanotechnology Initiative
Status and Progress in Manufacturing

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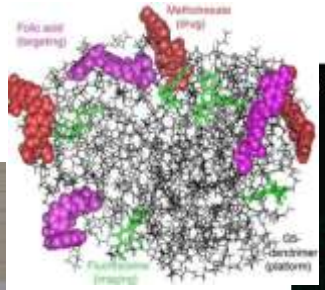
www.Nano.gov

NNI Vision

A future in which the ability to understand and control matter at the nanoscale leads to *a revolution in technology and industry that benefits society.*










NIH
OSTP
OMB
NSF
DOE
DOD
NIST
FDA
NASA
USDA/NIFA
USDA/ARS
NIOSH
National Nanotechnology Initiative
USDA/FS
Collaborative research and development that will advance understanding and control of matter at nanoscale for:
DOS
EPA
• National economic benefit
DOTr
NRC
• National security
USPTO
DOT
• Improved quality of life
USGS
ITIC
DOL
DOJ
DOEd
DOC/BIS
DHS
CPSC
ITC

NNI Signature Initiatives

The Nanotechnology Signature Initiatives (NSIs) spotlight areas of national significance that can be more rapidly advanced through focused and closely-coordinated inter-agency collaboration.
The NSIs

- Address R&D gaps within areas of critical national need
  - Identify research *thrust areas*
  - Select *key research targets* associated with near-and long-term expected outcomes
- *Leverage* skills, resources, and capabilities among multiple NNI agencies to maximize scientific and technological progress
- Provide a forum for communication and *ongoing assessment* of direction and progress
- *Catalyze* communities of practice and public private partnerships to accelerate commercialization

Nanotechnology Signature Initiatives

Released July 2010

- Nanotechnology for Solar Energy Collection and Conversion
- Sustainable Nanomanufacturing: Creating the Industries of the Future
- Nanoelectronics for 2020 and Beyond

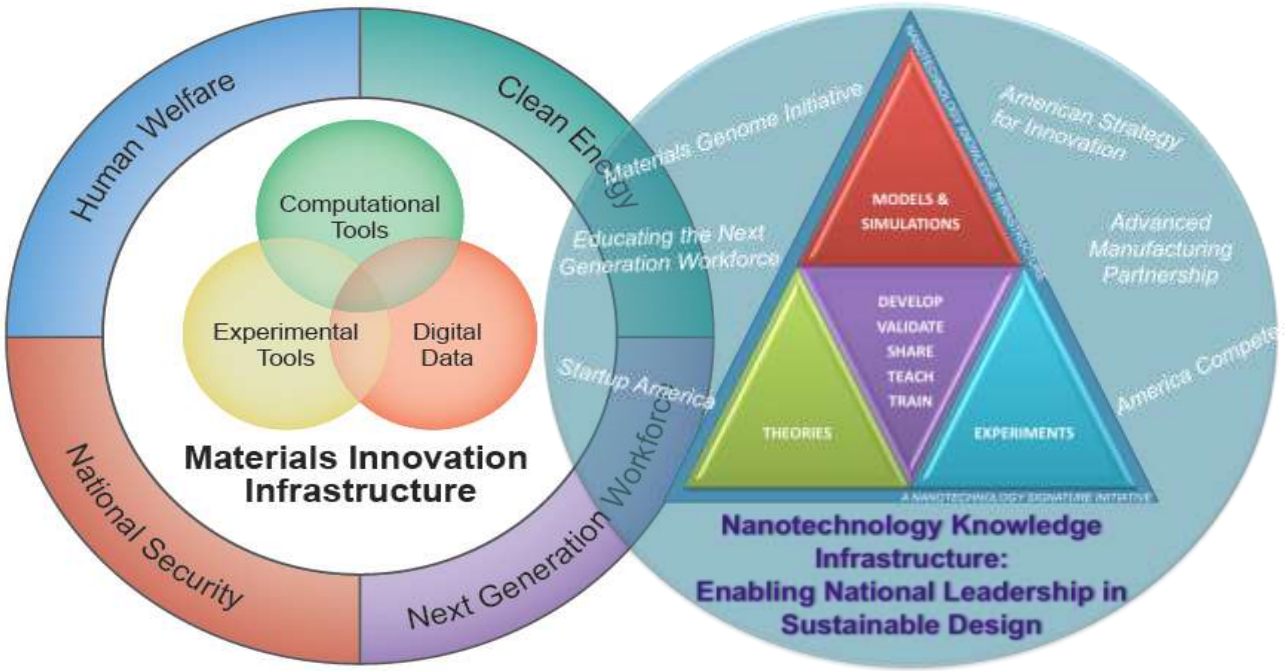
Released May 2012 with announcement of several other activities related to the Materials Genome Initiative

- Nanotechnology Knowledge Infrastructure: Enabling National Leadership in Sustainable Design (NKI)

Released July 2012

- Nanotechnology for Sensors and Sensors for Nanotechnology: Improving and Protecting Health, Safety, and the Environment

Identifying Synergies and Opportunities



For example: Potential areas for collaboration between NKI and MGI

- Understanding physical and chemical properties along the length and time scale
- Data and databases of mutual interest
- Procedural and technical issues in developing open innovation communities
  - e.g., IP and standards, data curation and federation, minimum information requirements
- Shared protocols and best practices

Sustainable Nanomanufacturing: Creating the Industries of the Future

Agencies involved: DOD, DOE, EPA, IC/DNI, NASA, NIH, NIOSH, NIST, NSF, OSHA, USDA/FS

Goal: Establish manufacturing technologies for economical and sustainable integration of nanoscale building blocks into complex, large scale systems.

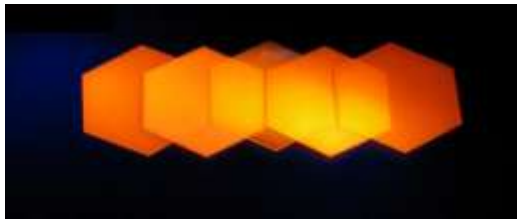
Thrust Areas:

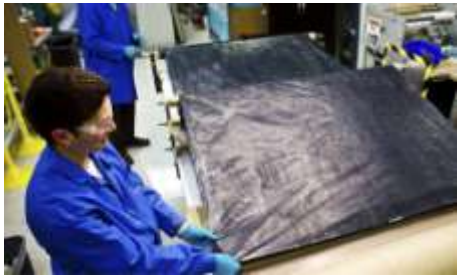
- Design of scalable and sustainable nanomaterials, components, devices, and processes
- Nanomanufacturing measurement technologies

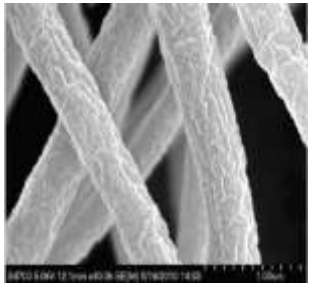
Initial focus areas will include manufactured products based on:

- Carbon-based nanomaterials
- Optical metamaterials
- Cellulosic nanomaterials

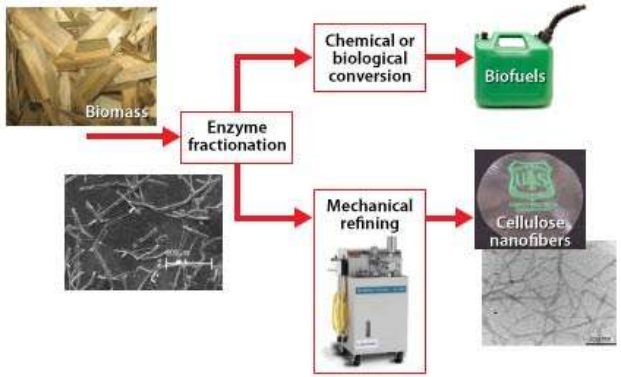
National Nanotechnology Initiative

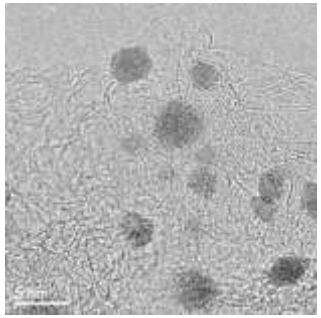






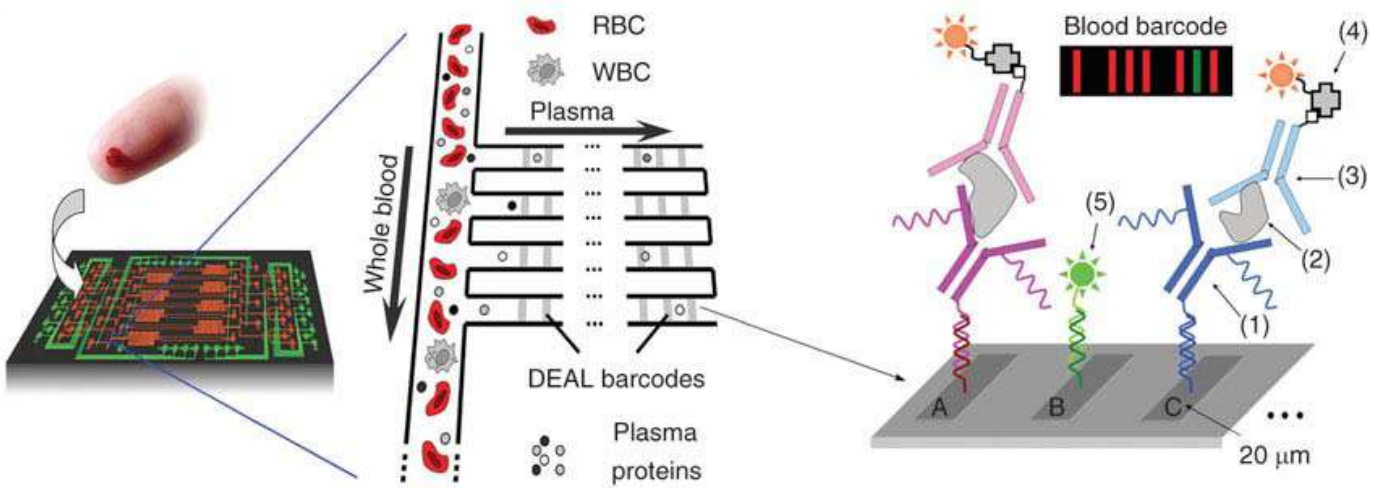
Affordable Energy Efficient Lighting
Lightweight Structural Materials
Sustainable Composites
Lightweight Efficient Electric Cabling
Maintenance Free Coatings
Catalysts





Lab-on-a-Chip to Monitor Therapeutic Response for Cancer Treatment

The Integrated Blood Barcode Chip (IBBC) : In-vitro assays to measure panel of biomarkers in Glioblastoma multiforme (GBM) patients being treated with Avastin to monitor therapeutic response.



Nature Biotechnology. (2008) 26: 1373-8

NCI Alliance for Nanotechnology in Cancer

Developing Small Tools with a Big Impact on Cancer

James Heath, Paul Mischel, Caltech/UCLA CCNE

Nanocellulose Pilot Plant at Forest Products Laboratory

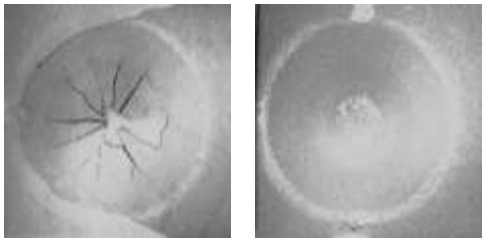
The Forest Service hosted a Grand Opening of a nanocellulose pilot plant July 25, 2012 at the Forest Service Forest Products Laboratory in Madison, WI. The $1.7 million pilot facility for renewable, forest-based nanomaterials is the first of its kind in the United States.

USDA Undersecretary Harris Sherman attended the ribbon cutting ceremony

Ceramic Nanocomposite Coatings

n-Al_2O_3-13TiO_2 coatings fabricated by conventional plasma spray
2X the bond strength and 4X the wear resistance
→ *Extraordinary deformability without failure*
Direct transition to fleet and industry (fully commercial)
Shipboard Applications:
Bronze Main Propulsion Shafting (MCM)
Submarine Components
Auxiliary and Main Ball Valves
Bow Plane Extenders (Seawolf)
Hydraulic Lift Cylinders

MCM shafts fail after 18mos service requiring dry docking for weld repair



No failure even after severe deformation

NANOCOMPOSITE COATING
No visible damage after
Seven years of service

Uncoated shaft experiences severe scoring damage

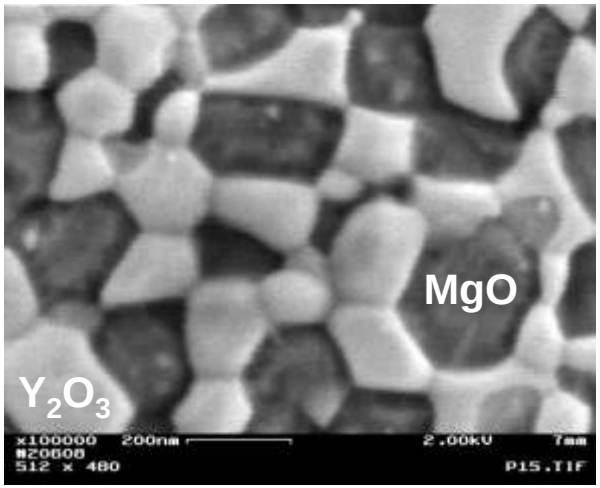
POC: Dr. Lawrence Kabacoff

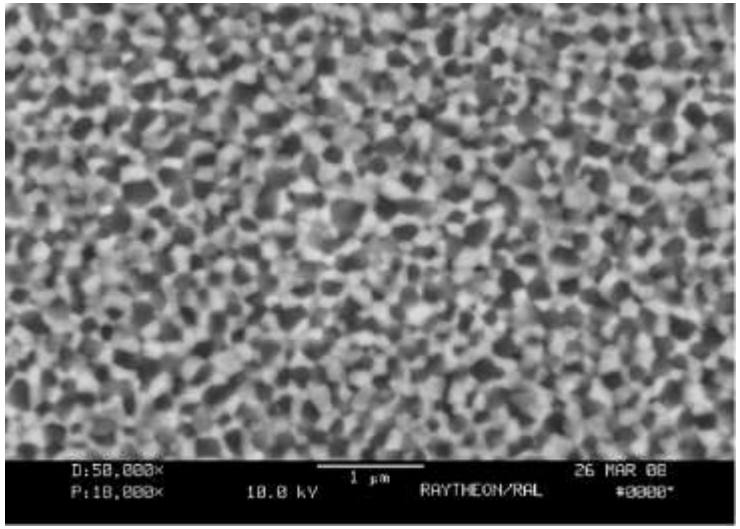
Optical Nanocomposites Enhance Window Durability and Transparency

Maximizing the Optical and Mechanical Performance

The goal is to achieve all of the following simultaneously:
- High Strength - equivalent to Sapphire
- Scalable Method - able to produce 3” domes
- MWIR Transparent - equivalent to Spinel
- Stretch goal: MWIR Transparency - equivalent to Yttria

To achieve these goals:
- No porosity
- Minimize grain size / grain growth: G.S. $\leq$ l/20 for transparency
- Avoid MWIR absorptions due to Si-O or Al-O bonds
- Uniform 2-phase microstructure: MgO – Y_2O_3 (M:Y)





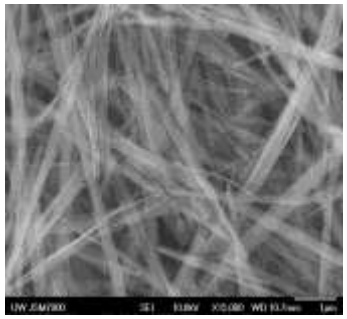
Uniform microstructure with ~150 nm grain size.

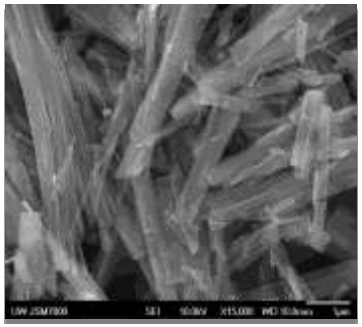
M:Y Nanocomposite Microstructures

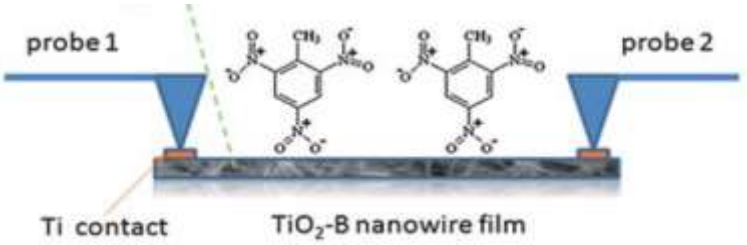
Dr. Rick Gentilman, Raytheon

Miniature Semi-Conductor Nanowire Sensor for Explosive Detection

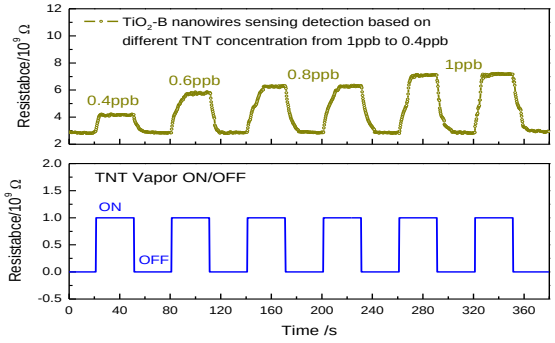
p-type Si Nanowire sensors



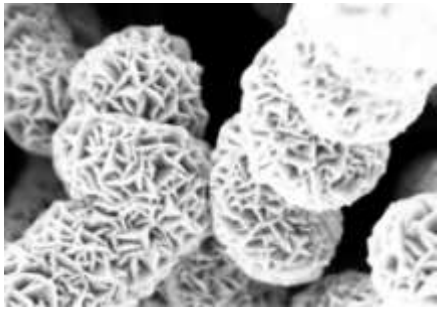


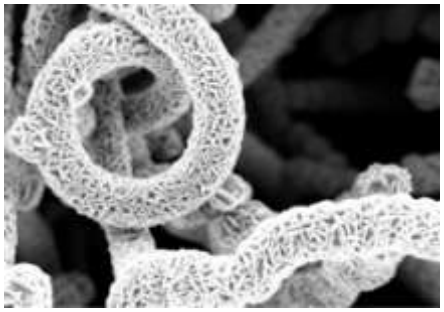


Explosive electronegative - ΔR surface charge depletion (n-type semicond.)

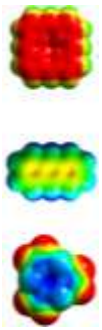


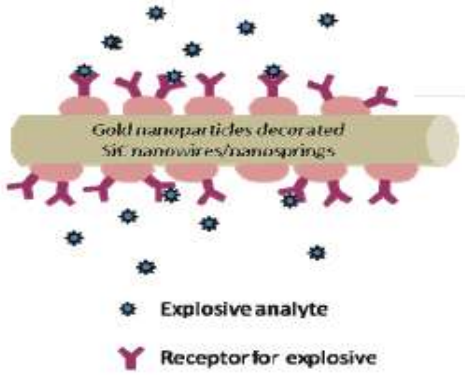
ZnO on Silica (SiO_2) nano-springs





Chemical / protein / fluorophores receptors, specifically designed for selective explosive molecule size and bond configuration, coat nanowires





Translation of Products (Concept to Deployment)

Understand the Playing Field
- Problem Being Solved
- Market Needs/ Requirements

Understand Competing Technologies
- Change that Can Affect You

Change the Playing Field

Who Cares

Road to Commercialization

Resources
- Small Business
- Facilities

Market Expertise
- Commercial
- Government (Military)

Talent
- Technical (Technician to PhD)
- Management
  - Experience
  - Leadership
  - Will to Succeed

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